US009347326B2

(12) **United States Patent**
Kim et al.

(10) **Patent No.: US 9,347,326 B2**
(45) **Date of Patent: May 24, 2016**

(54) **INTEGRAL COVER BUCKET ASSEMBLY**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 740 days.

(21) Appl. No.: **13/667,930**

(22) Filed: **Nov. 2, 2012**

(65) **Prior Publication Data**

US 2014/0127020 A1 May 8, 2014

(51) **Int. Cl.**
F01D 5/22 (2006.01)
F01D 5/30 (2006.01)

(52) **U.S. Cl.**
CPC ***F01D 5/22*** (2013.01); ***F01D 5/303*** (2013.01); *F05D 2220/31* (2013.01); *Y10T 29/49321* (2015.01)

(58) **Field of Classification Search**
CPC F01D 5/22; F01D 5/225; F01D 5/303; F01D 5/303; F01D 5/30; F01D 25/04; F01D 25/06; F05D 2220/31; F05D 2260/96; Y10T 29/49321
USPC .... 416/190, 191, 220, 220 R, 215–217; 29/889.21
See application file for complete search history.

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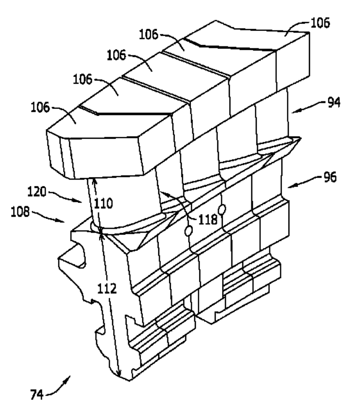
(57) **ABSTRACT**

A bucket assembly includes a plurality of first buckets, and a pair of transition buckets. Each first bucket includes a bucket cover including a pair of lateral edges each having a first configuration. Each transition bucket includes a transition cover including a first lateral edge having the first configuration and a second lateral edge having a second configuration.

20 Claims, 4 Drawing Sheets



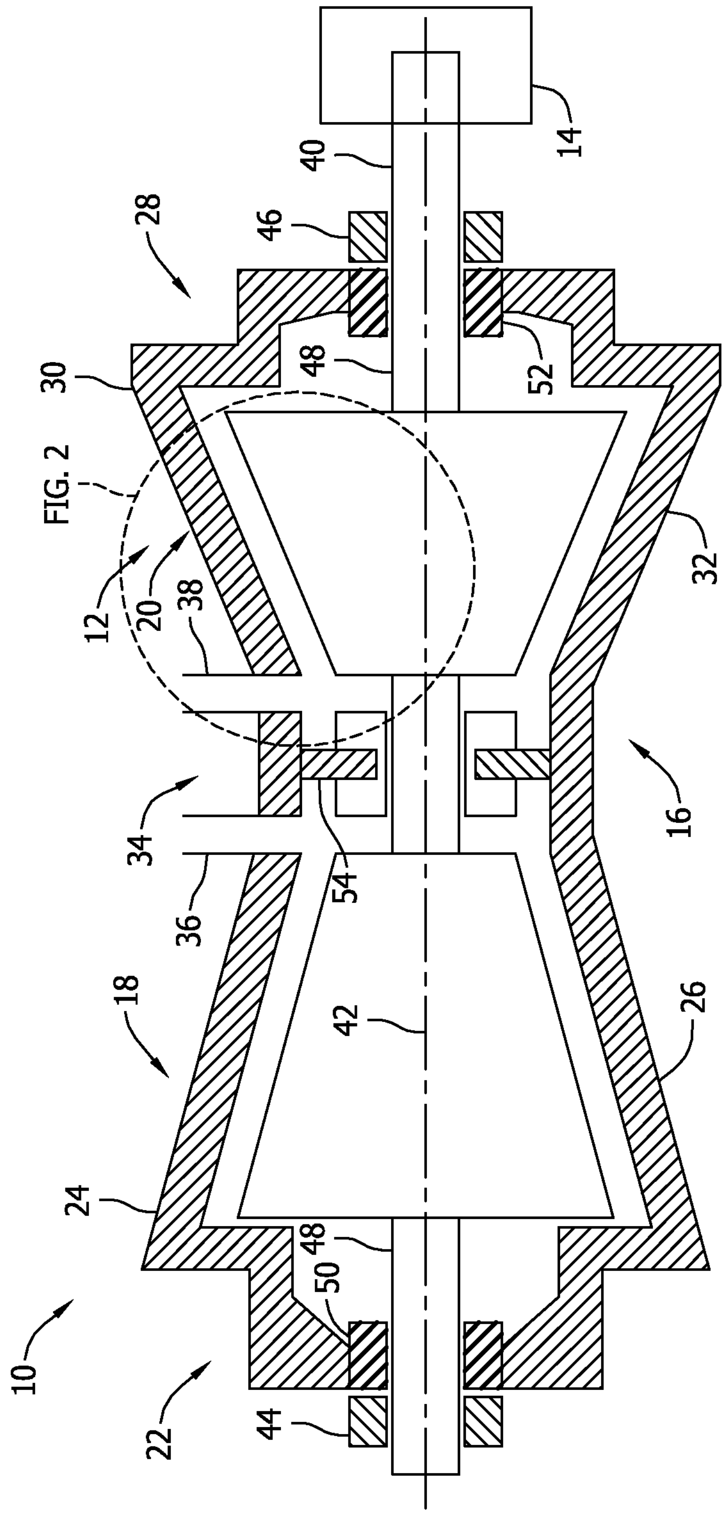

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FIG. 2
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FIG. 1

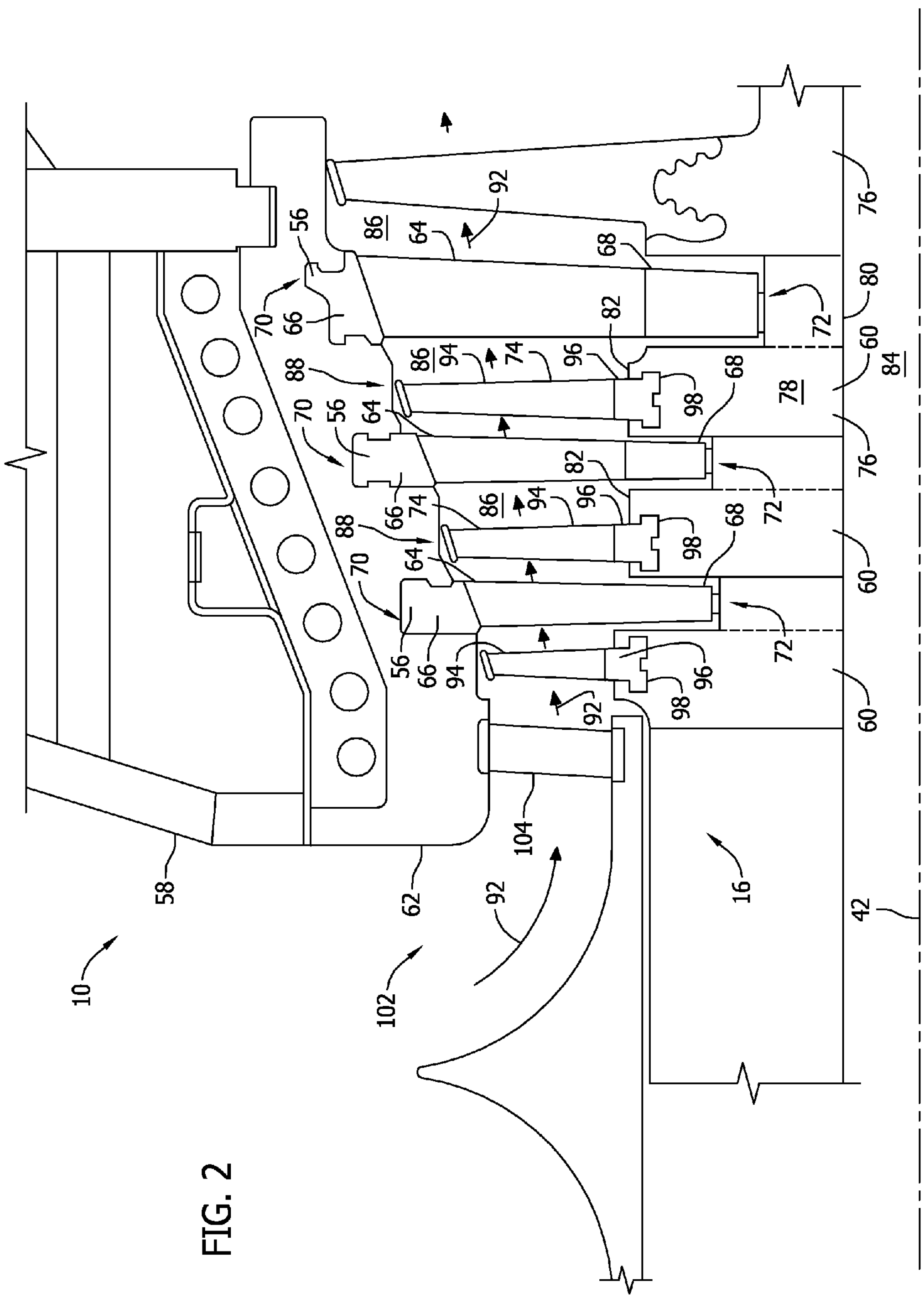
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FIG. 2

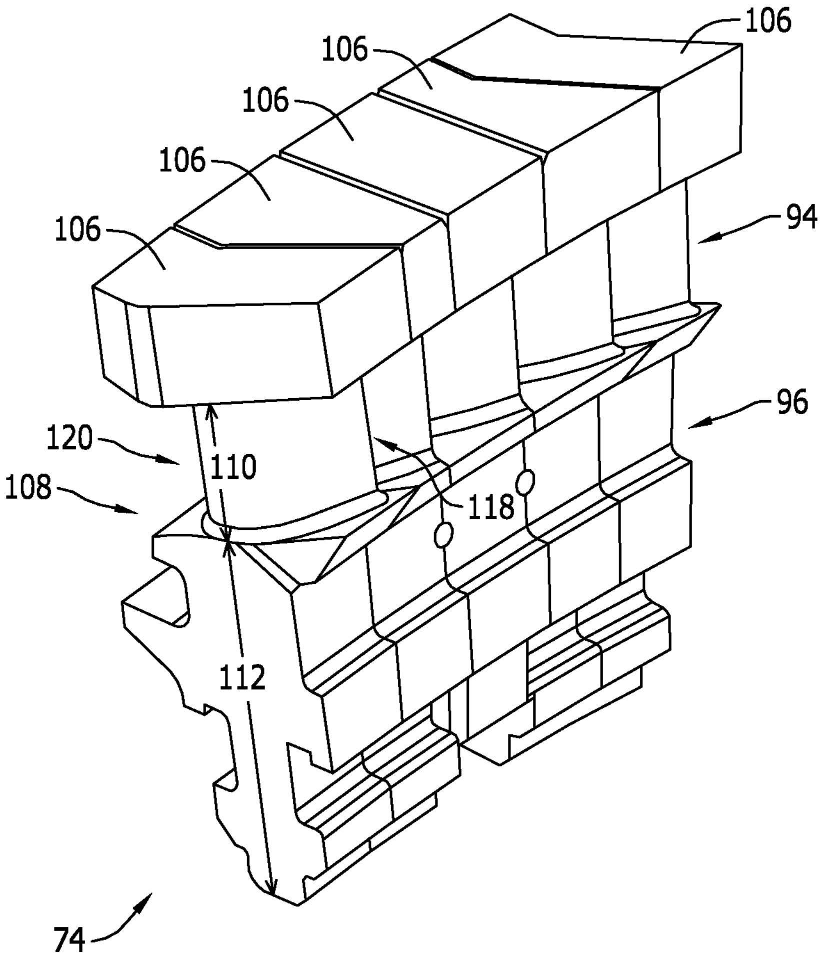

FIG. 3

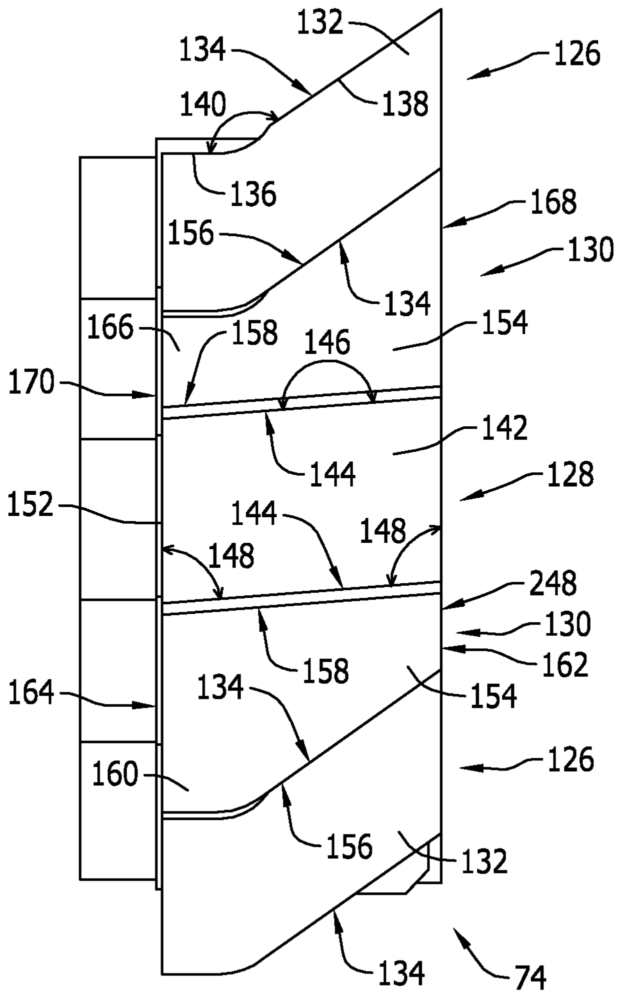
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FIG. 4

INTEGRAL COVER BUCKET ASSEMBLY

BACKGROUND

The present disclosure relates generally to turbine engines and, more particularly, to a bucket assembly for use in a turbine engine.

At least some known turbine engines include a rotor assembly including a rotor disk and a bucket assembly coupled to the rotor disk. Some known bucket assemblies include buckets including a cover, an airfoil, and a dovetail. Although known dovetails facilitate coupling the buckets to the rotor disk, the coupling process may be tedious and/or time consuming. For example, the cover of one bucket may interfere with the dovetail and/or the airfoil of a circumferentially-adjacent bucket during assembly. To position such buckets next to a circumferentially-adjacent bucket that was previously installed, at least a portion of the bucket may be removed and/or trimmed such that the cover no longer interferes with the dovetail and/or the airfoil of the adjacent bucket. However, removing and/or trimming a portion of the bucket may decrease a performance of the turbine engine.

BRIEF SUMMARY

In one aspect, a method is provided for use in assembling a bucket assembly. The method includes coupling a first bucket and a second bucket to a rotor disk. The first and second buckets each include a bucket cover that includes a pair of lateral edges that are each formed in a first configuration. A first transition bucket is coupled to the rotor disk and against the first bucket. The first transition bucket includes a first transition cover that includes a first lateral edge formed in the first configuration and a second lateral edge formed in a second configuration. A second transition bucket is coupled to the second bucket. The second transition bucket includes a second transition cover that includes a first lateral edge formed in the first configuration and a second lateral edge formed in the second configuration.

In another aspect, a bucket assembly is provided for use with a turbine engine. The bucket assembly includes a plurality of first buckets, and a pair of transition buckets. Each first bucket includes a bucket cover including a pair of lateral edges each formed in a first configuration. Each transition bucket includes a transition cover including a first lateral edge formed in the first configuration and a second lateral edge formed in a second configuration.

In yet another aspect, a turbine engine is provided. The turbine engine includes a rotor disk, and a bucket assembly coupled to the rotor disk. The bucket assembly includes a plurality of buckets, and a pair of transition buckets. Each bucket of the plurality of buckets includes a bucket cover including a pair of lateral edges each formed in a first configuration. Each transition bucket of the pair of transition buckets includes a transition cover including a first lateral edge formed in the first configuration and a second lateral edge formed in a second configuration.

The features, functions, and advantages described herein may be achieved independently in various embodiments described in the present disclosure or may be combined in yet other embodiments, further details of which may be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic illustration of an exemplary turbine engine;

FIG. **2** is an enlarged schematic illustration of a portion of the turbine engine shown in FIG. **1** and taken along area **2**;

FIG. **3** is a perspective view of an exemplary bucket assembly used with the turbine engine shown in FIG. **1**; and

FIG. **4** is a top view of the bucket assembly shown in FIG. **3**.

Although specific features of various embodiments may be shown in some drawings and not in others, this is for convenience only. Any feature of any drawing may be referenced and/or claimed in combination with any feature of any other drawing.

DETAILED DESCRIPTION

The present disclosure relates generally to turbine engines and, more particularly, to bucket assemblies for use in a turbine engine. In some embodiments, the bucket assembly includes a plurality of integral covered (IC) buckets. As used herein, the term "integral" refers to a bucket that includes a cover. The bucket may be integrally formed with the cover (e.g., via machining from bar stock material, wherein the vane and cover are machined from the same piece of bar stock, or casting) or, alternatively, the cover may be integrally coupled to the airfoil (e.g., via welding). In one embodiment, the plurality of IC buckets include a plurality of first buckets, and at least a pair of transition buckets. Each first bucket includes a bucket cover including a pair of lateral edges each formed in a first configuration. Each transition bucket includes a transition cover including a first lateral edge formed with the first configuration and a second lateral edge formed in a second configuration. As such, the bucket assembly may be assembled without requiring modification of or removal of a portion of any of the buckets.

As used herein, an element or step recited in the singular and preceded with the word "a" or "an" should be understood as not excluding plural elements or steps unless such exclusion is explicitly recited. Moreover, references to "one embodiment" are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features.

FIG. **1** is a schematic illustration of an exemplary turbine engine **10**. In some embodiments, turbine engine **10** is an opposed-flow, high-pressure (HP) and intermediate-pressure (IP) steam turbine assembly. In other embodiments, turbine engine **10** may be any type of steam turbine, such as, without limitation, a low-pressure turbine, a single-flow steam turbine, and/or a double-flow steam turbine.

In some embodiments, turbine engine **10** includes a turbine **12** that is coupled to a generator **14** via a rotor assembly **16**. In some embodiments, turbine **12** includes a HP section **18** and an IP section **20**. An HP casing **22** is divided axially into upper and lower half sections **24** and **26**, respectively. Similarly, an IP casing **28** is divided axially into upper and lower half sections **30** and **32**, respectively. A central section **34** extends between HP section **18** and IP section **20**, and includes an HP steam inlet **36** and an IP steam inlet **38**.

Rotor assembly **16** extends between HP section **18** and IP section **20** and includes a rotor shaft **40** that extends along a centerline axis **42** between HP section **18** and IP section **20**. Rotor shaft **40** is supported from casing **22** and **28** by journal bearings **44** and **46**, respectively, that are each coupled to opposite end portions **48** of rotor shaft **40**. Steam seal units **50** and **52** are coupled between rotor shaft end portions **48** and casings **22** and **28** to facilitate sealing HP section **18** and IP section **20**.

An annular divider **54** extends radially inwardly between HP section **18** and IP section **20** from central section **34** towards rotor assembly **16**. More specifically, divider **54** extends circumferentially about rotor assembly **16** between HP steam inlet **36** and IP steam inlet **38**.

During operation, steam is channeled to turbine **12** from a steam source, for example, a power boiler (not shown), wherein steam thermal energy is converted to mechanical rotational energy by turbine **12**, and subsequently electrical energy by generator **14**. More specifically, steam is channeled through HP section **18** from HP steam inlet **36** to impact rotor assembly **16** positioned within HP section **18** and to induce rotation of rotor assembly **16** about axis **42**. Steam exits HP section **18** and is channeled to a boiler (not shown) that increases a temperature of the steam to a temperature that is approximately equal to a temperature of steam entering HP section **18**. Steam is then channeled to IP steam inlet **38** and to IP section **20** at a reduced pressure than a pressure of the steam entering HP section **18**. The steam impacts the rotor assembly **16** that is positioned within IP section **20** to induce rotation of rotor assembly **16**.

FIG. **2** is an enlarged schematic illustration of a portion of turbine engine **10** taken along area **2**. In some embodiments, turbine engine **10** includes rotor assembly **16**, a plurality of stationary diaphragm assemblies **56**, and a casing **58** that extends circumferentially about rotor assembly **16** and diaphragm assemblies **56**. Rotor assembly **16** includes a plurality of rotor disk assemblies **60** that are each aligned substantially axially between each adjacent pair of diaphragm assemblies **56**. Each diaphragm assembly **56** is coupled to casing **58**, and casing **58** includes a nozzle carrier **62** that extends radially inwardly from casing **58** towards rotor assembly **16**. Each diaphragm assembly **56** is coupled to nozzle carrier **62** to facilitate preventing diaphragm assembly **56** from rotating with respect to rotor assembly **16**. Each diaphragm assembly **56** includes a plurality of circumferentially-spaced nozzles **64** that extend from a radially outer portion **66** to a radially inner portion **68**. Nozzle outer portion **66** is positioned within a recessed portion **70** defined within nozzle carrier **62** to enable diaphragm assembly **56** to couple to nozzle carrier **62**. Nozzle inner portion **68** is positioned adjacent to rotor disk assembly **60**. In one embodiment, inner portion **68** includes a plurality of sealing assemblies **72** that form a tortuous sealing path between diaphragm assembly **56** and rotor disk assembly **60**.

In some embodiments, each rotor disk assembly **60** includes a plurality of turbine buckets **74** that are each coupled to a rotor disk **76**. Rotor disk **76** includes a disk body **78** that extends between a radially inner portion **80** and a radially outer portion **82**. Radially inner portion **80** defines a central bore **84** that extends generally axially through rotor disk **76**. Disk body **78** extends radially outwardly from central bore **84**.

Each turbine bucket **74** is coupled to rotor disk outer portion **82** such that buckets **74** are circumferentially-spaced about rotor disk **76**. Each turbine bucket **74** extends radially outwardly from rotor disk **76** towards casing **58**. Adjacent rotor disks **76** are coupled together such that a gap **86** is defined between each axially-adjacent row **88** of circumferentially-spaced turbine buckets **74**. Nozzles **64** are spaced circumferentially about each rotor disk **76** and between adjacent rows **88** of turbine buckets **74** to channel steam downstream towards turbine buckets **74**. A steam flow path **92** is defined between turbine casing **58** and each rotor disk **76**.

In some embodiments, each turbine bucket **74** is coupled to an outer portion **82** of a respective rotor disk **76** such that each turbine bucket **74** extends into steam flow path **92**. More specifically, each turbine bucket **74** includes a vane or airfoil **94** that extends radially outwardly from a dovetail **96**. Each dovetail **96** is inserted into a dovetail groove **98** defined within an outer portion **82** of rotor disk **76** to enable turbine bucket **74** to be coupled to rotor disk **76**.

During operation of turbine engine **10**, steam is channeled into turbine **12** through a steam inlet **102** and into steam flow path **92**. Each inlet nozzle **104** and diaphragm assemblies **56** channel the steam towards turbine buckets **74**. As steam impacts each turbine bucket **74**, turbine bucket **74** and rotor disk **76** are rotated circumferentially about axis **42**.

FIG. **3** is a perspective view of buckets **74**. FIG. **4** is a top view of buckets **74**. In some embodiments, each bucket **74** includes a cover **106** and a body **108** that extends radially inwardly from cover **106**. In some embodiments, bodies **108** have the same and/or a substantially similar configuration. Body **108** includes airfoil **94** and dovetail **96**. In some embodiments, an airfoil height **110** is shorter than a dovetail height **112**. Alternatively, in other embodiments, airfoil **94** and/or dovetail **96** may have any height that enables bucket **74** to function as described herein. Airfoil **94** includes a leading edge **118** and an opposite trailing edge **120**. More specifically, airfoil trailing edge **120** is spaced chord-wise and downstream from airfoil leading edge **118**.

In some embodiments, buckets **74** include a plurality of buckets **126**, a closure bucket **128**, and at least a pair of transition buckets **130**. In some embodiments, each cover **106** for each bucket **126** is a bucket cover **132** that includes a pair of lateral edges **134** that each has a first configuration. For example, in some embodiments, lateral edges **134** are substantially parallel to each other. In the exemplary embodiment, each lateral edge **134** includes a first segment **136** and a second segment **138** that extends obliquely from first segment **136** at an angle **140** such that the first configuration is an angled configuration. In the exemplary embodiment, angle **140** is between approximately 95° and approximately 175°. More specifically, in the exemplary embodiment, angle **140** is between approximately 120° and approximately 150°. Alternatively, in other embodiments, lateral edges **134** may have any configuration that enables bucket cover **132** to function as described herein.

In some embodiments, each cover **106** for closure bucket **128** is a closure cover **142** that includes a pair of lateral edges **144** that each has a second configuration. For example, in some embodiments, lateral edges **144** are substantially parallel to each other. In the exemplary embodiment, each lateral edge **144** defines or has an angle **146** that is greater than angle **140** and that is less than or equal to approximately 180°. More specifically, in the exemplary embodiment, angle **146** is approximately 180° such that lateral edge **144** is a substantially straight configuration.

Moreover, in some embodiments, each angle **148** defined between a lateral edge **144** and either a leading edge **150** or a trailing edge **152** is between approximately 60° and approximately 120° such that closure cover **142** has a substantially rectangular configuration. More specifically, in at least some embodiments, angle **148** is between approximately 75° and 105°. Alternatively, in other embodiments, lateral, leading, and/or trailing edges **144**, **150**, and **152**, respectively, may have any configuration that enables closure cover **142** to function as described herein.

In some embodiments, each cover **106** for each transition bucket **130** is a transition cover **154** that includes a first lateral edge **156** formed in the first configuration and a second lateral edge **158** formed in the second configuration. Accordingly, in at least some embodiments, each transition bucket **130** is positionable between a respective bucket **126** and closure bucket **128** in only one orientation. In some embodiments, a first transition bucket **160** has a leading edge **162** that is shorter than a trailing edge **164**, and a second transition bucket **166** has a leading edge **168** that is longer than a trailing edge **170**. In some embodiments, transition buckets **160** and **166** are coupleable to each other along their respective second lateral edges **158**.

During assembly, each dovetail **96** for each bucket **126** is inserted into dovetail groove **98** to couple buckets **126** to rotor disk **76**. Each dovetail **96** for each transition bucket **130** is inserted into dovetail groove to couple transition buckets **130** to rotor disk **76**. More specifically, in at least some embodiments, first transition bucket **160** is slid in a first circumferential direction to couple first transition bucket **160** to a first bucket **126**, and second transition bucket **166** is slid in a second, opposite circumferential direction to couple second transition bucket **166** to a second bucket **126** such that a gap (not shown) is defined between transition buckets **160** and **166**. Closure bucket **128** is positioned between transition buckets **160** and **166** to assemble a bucket assembly. Use of closure bucket **128** enables an easier assembly process when compared to a row of buckets which have all the same cover angle. Alternatively, in at least some embodiments, first transition bucket **160** may be directly coupled to second transition bucket **166** without the use of closure bucket **128**.

The present disclosure relates generally to turbine engines and, more particularly, to a bucket assembly for use in a turbine engine. The embodiments described herein enable an application space of an integral covered (IC) bucket assembly including a plurality of IC buckets to be increased without removing a portion of at least one of the IC buckets during assembly of the IC bucket assembly. Accordingly, the embodiments described herein facilitate decreasing an assembly time of the IC bucket assembly and/or enhancing the performance of the IC bucket assembly

Exemplary embodiments of a bucket assembly are described above in detail. The methods and systems are not limited to the embodiments described herein, but rather, components of systems and/or steps of the method may be utilized independently and separately from other components and/or steps described herein. Each method step and each component may also be used in combination with other method steps and/or components. Although specific features of various embodiments may be shown in some drawings and not in others, this is for convenience only. Any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

This written description uses various embodiments to disclose the subject matter, including the best mode, and also to enable any person skilled in the art to practice the embodiments, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the disclosure is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

What is claimed is:

1. A method of assembling a bucket assembly, the method comprising:

inserting a dovetail of each of a first bucket, a first transition bucket, a second transition bucket, and a second bucket into a dovetail groove defined circumferentially within a rotor disk, the first and second buckets each including a bucket cover that includes a pair of lateral edges that are each formed in a first configuration;

coupling the first transition bucket against the first bucket by sliding the first transition bucket in a first circumferential direction along the dovetail groove, the first transition bucket including a first transition cover that includes a first lateral edge that is formed in the first configuration and a second lateral edge that is formed in a second configuration; and

coupling the second transition bucket against the second bucket by sliding the second transition bucket in a second circumferential direction along the dovetail groove opposite the first circumferential direction, the second transition bucket including a second transition cover that includes a first lateral edge that is formed in the first configuration and a second lateral edge that is formed in the second configuration.

2. A method in accordance with claim **1** further comprising coupling a closure bucket to the rotor disk and between the first transition bucket and the second transition bucket, the closure bucket including a closure cover that includes a pair of lateral edges that are each formed in the second configuration.

3. A method in accordance with claim **2**, wherein coupling a closure bucket further comprises providing each closure cover lateral edge to be substantially straight such that the second configuration is a substantially straight configuration.

4. A method in accordance with claim **2** further comprising providing the first bucket, the second bucket, the closure bucket, the first transition bucket, and the second transition bucket to include a body extending radially inwardly from a respective cover, wherein the bodies are substantially similar to each other.

5. A method in accordance with claim **2** further comprising providing the first bucket, the second bucket, the closure bucket, the first transition bucket, and the second transition bucket to include an airfoil extending radially inwardly from a respective cover, and a dovetail extending radially inwardly from a respective airfoil, wherein an airfoil height is shorter than a dovetail height.

6. A method in accordance with claim **1**, wherein coupling a first bucket and a second bucket further comprises providing each bucket cover lateral edge to include a first segment and a second segment that extends from the first segment at an angle such that the first configuration is an angled configuration.

7. A method in accordance with claim **1**, wherein coupling a first transition bucket further comprises providing the first transition bucket to include a leading edge that is shorter than a trailing edge of the first transition bucket, and wherein coupling a second transition bucket further comprises providing the second transition bucket to include a leading edge that is longer than a trailing edge of the second transition bucket.

8. A bucket assembly for use with a turbine engine, said bucket assembly comprising:

a plurality of first buckets, each first bucket comprising a dovetail configured for insertion into a dovetail groove defined circumferentially within a rotor disk of the turbine engine, and a bucket cover including a pair of lateral edges each formed in a first configuration; and

a pair of transition buckets, each transition bucket comprising a dovetail configured for insertion into the dovetail groove and a transition cover including a first lateral edge formed in the first configuration and a second lateral edge formed in a second configuration, wherein a first of the transition buckets is slidable along the dovetail groove in a first circumferential direction to couple against one of the first buckets and a second of the transition buckets is slidable in a second circumferential direction along the dovetail groove opposite the first circumferential direction to couple against another of the first buckets.

9. A bucket assembly in accordance with claim 8 further comprising a closure bucket comprising a closure cover including a pair of lateral edges each formed in the second configuration.

10. A bucket assembly in accordance with claim 9, wherein each closure cover lateral edge is substantially straight such that the second configuration is a substantially straight configuration.

11. A bucket assembly in accordance with claim 9, wherein each first bucket, the closure bucket, and each transition bucket comprises a body extending radially inwardly from a respective cover, wherein the bodies are substantially similar to each other.

12. A bucket assembly in accordance with claim 8, wherein each bucket cover lateral edge comprises a first segment and a second segment that extends from the first segment at an angle such that the first configuration is an angled configuration.

13. A bucket assembly in accordance with claim 8, wherein a first transition bucket has a leading edge that is shorter than a trailing edge of the first transition bucket, and a second transition bucket has a leading edge that is longer than a trailing edge of the second transition bucket.

14. A turbine engine comprising:

a rotor disk comprising a dovetail groove defined circumferentially therein; and

a bucket assembly coupled to the rotor disk, the bucket assembly comprising a plurality of first buckets and a pair of transition buckets, wherein each first bucket comprises a dovetail configured for insertion into the dovetail groove and a bucket cover including a pair of lateral edges each formed in a first configuration, and each transition bucket of the pair of transition buckets comprises a dovetail configured for insertion into the dovetail groove and a transition cover including a first lateral edge formed in the first configuration and a second lateral edge formed in a second configuration, wherein a first of the transition buckets is slidable in a first circumferential direction along the dovetail groove to couple against one of the first buckets and a second of the transition buckets is slidable in a second circumferential direction along the dovetail groove opposite the first circumferential direction to couple against another of the first buckets.

15. A turbine engine in accordance with claim 14, wherein the bucket assembly further comprises a closure bucket comprising a closure cover including a pair of lateral edges each formed in the second configuration.

16. A bucket assembly in accordance with claim 15, wherein each closure cover lateral edge is substantially straight such that the second configuration is a substantially straight configuration.

17. A bucket assembly in accordance with claim 15, wherein each first bucket, the closure bucket, and each transition bucket comprises a body extending radially inwardly from a respective cover, wherein the bodies are substantially similar to each other.

18. A bucket assembly in accordance with claim 15, wherein each first bucket, the closure bucket, and each transition bucket comprises an airfoil extending radially inwardly from a respective cover, and a dovetail extending radially inwardly from a respective airfoil, wherein an airfoil height is shorter than a dovetail height.

19. A turbine engine in accordance with claim 14, wherein each bucket cover lateral edge comprises a first segment and a second segment that extends from the first segment at an angle such that the first configuration is an angled configuration.

20. A bucket assembly in accordance with claim 14, wherein a first transition bucket has a leading edge that is shorter than a trailing edge of the first transition bucket, and a second transition bucket has a leading edge that is longer than a trailing edge of the second transition bucket.

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